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✓ *FOREST RENEWAL* *FOREST IMPROVEMENT* *NURSERIES* *TREE IMPROVEMENT* *MISC.*

CONTROLLING KALMIA WITH A VISION® + SYLGARD® 309 MIXTURE

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INTRODUCTION

Newfoundland foresters have long associated the presence of *Kalmia angustifolia* L. (sheep laurel, lambkill, *Kalmia*) with poor black spruce growth performance on regenerating sites. This species is considered by many to be the most serious impediment to successful plantation establishment on poor and medium sites on the eastern half of the island. The typical reforestation regime presently used for *Kalmia*-dominated (or susceptible) sites consists of rigorous trench scarification within five years of harvest, followed by the planting of black spruce container seedlings. Although this approach sets back the advance of *Kalmia* for a time, it is often not enough to allow the planted trees to develop to the point where they are free to grow without being inhibited by *Kalmia*.

To identify alternatives for reforesting *Kalmia*-dominated sites, a comprehensive *Kalmia* management trial was established near Botwood in central Newfoundland in 1989 (Titus and Meades, 1988). An array of options, including scarification, fertilization, *Kalmia* eradication (using herbicides) and several reforestation species, alone and in combination, were tested in this trial. The fifth year results (Titus, 1995) showed that controlling *Kalmia* with herbicides improved conifer seedling growth. However, this treatment required application of three different herbicides (Velpar L®, Garlon 4® and Vision®) at different times over the growing season prior to planting, plus spot application of Vision® in subsequent years. Other greenhouse and field trials have also demonstrated the difficulties of chemically controlling *Kalmia* (Richardson, 1979; Titus et al., 1995).

As conifer seedling growth will improve if *Kalmia* can be even partially controlled using

herbicides, there is a need to test more recently available products in the field. Furthermore, *Kalmia* leaves have waxy cuticles that may inhibit absorption, and foliar uptake of herbicides may be improved by addition of surfactants (additives that improve the spreading of the herbicide solution over the leaf surface, thereby enhancing the amount and rate of uptake). Herbicides may also be more effective at different times of the year. A herbicide efficacy trial was therefore established on two different *Kalmia*-dominated sites in central Newfoundland to compare two silvicultural herbicides, Vision® and Release®. These were applied with and without the surfactant Sylgard® 309 at two different times during the growing season. Initial results were reported in Titus and English (1997), and this present note summarizes third year results. In addition, black spruce growth at the Botwood *Kalmia* management trial was re-measured after eight growing seasons to determine the potential conifer response when *Kalmia* is controlled using herbicides.

METHODS

Botwood Kalmia Reforestation Field Trial

This trial consists of all 12 factorial combinations (2 X 2 X 3) of TTS scarification, herbicide application and two different fertilization formulations, repeated for black spruce, jack pine and eastern larch. Herbicide treatments consisted of sequential applications of Velpar L®, Garlon 4® and Vision® at maximum label dosages before planting, followed by spot application of Vision® in the third, fifth and seventh growing seasons. (The Botwood trial was designed to test the effect of a reduction of *Kalmia* cover on subsequent conifer performance, and was not designed as an efficacy trial.) Treatment plots were 30 X 10 m, and planted with 150 seedlings at 1 X 2 m spacing. Some seedlings were destructively sampled after two, three and five years, and all plots were thinned during the sixth growing season to leave approximately 75 seedlings at 2 X 2 m spacing in each treatment plot. All treatments were replicated in four blocks.

Total conifer height, conifer leader growth and *Kalmia* cover were assessed at two, three and five years after planting. Spruce growth was assessed again eight years after planting, but only in four treatments of immediate silvicultural interest (untreated control, scarification only, herbicide only, and scarification + herbicide).

Herbicide Efficacy Field Trials

Site Description: The first of the two herbicide efficacy trials, Twin Ponds, was established on Corner Brook Pulp and Paper Ltd. licensed land on a branch of Cross Country Pond Forest Access Road, approximately 11 km due north of Glenwood in Forest Management District 08 (N 49° 6', W 54° 53' on National Topographic Mapsheet 02 E/2-21). The medium quality site originally supported a black spruce forest, and was clearcut in the mid- to late 1980s. The resultant cutover was mechanically site prepared with a TTS disc trencher in 1990 and planted with black spruce container seedlings in 1991. The trial is located on a flat,

imperfectly drained site dominated by *Kalmia*. The second trial, Camp Six, was established on Abitibi-Consolidated Inc. licensed land on a branch of Camp Six Forest Access Road, approximately 6 km southeast of Bishops Falls in Forest Management District 11 (N 48° 59', W 55° 26' on National Topographic Mapsheet 02 D/14-41) and 41.5 km west of the Twin Ponds trial. The Camp Six site is also of medium quality and originally supported a black spruce forest that was clearcut in the mid- to late 1980s. Natural conifer regeneration was sporadic at the time of trial establishment and the ground vegetation was dominated by *Kalmia*. The trial is on a gentle, well-drained, west-facing slope.

Experimental Design: Each trial was established using a randomized complete-block design consisting of nine treatment plots replicated in four blocks. Each plot was 10 X 10 m with a 2 m no-spray buffer strip between adjacent plots to minimize the impact of drift. The treatments tested at both trial sites are described in Table 1. First, two prominent silvicultural herbicides, Vision® and Release®, were compared. Secondly, each herbicide was tested with and without the surfactant Sylgard® 309 to see if the addition of surfactant would enhance the ability of the herbicide to penetrate the waxy cuticle of *Kalmia* leaves and increase efficacy. Finally, all of the above treatments were tested in early July (mid-growing season) and again at the end of August (late growing season) to see if *Kalmia* susceptibility to herbicides was related to timing of application and the physiological status of the *Kalmia* plants. An untreated control treatment was also included.

Products: Vision® is a silvicultural herbicide produced by Monsanto Canada Inc. The active ingredient, glyphosate, is present in the product as isopropylamine salt (41% by volume). The two other ingredients are water (44% by volume) and an unidentified surfactant (15% by volume).

Release® is a silvicultural herbicide produced by Dow Elanco Canada Inc. The active ingredient, triclopyr, is present in the product

Table 1. Treatments tested in the 1995 herbicide efficacy trials at Twin Ponds and Camp Six.

Treatment	Herbicide	Surfactant	Application Date
Control	-	-	-
Release only / July	Release	none	July 5 - 9
Release + Sylgard / July	Release	Sylgard	July 5 - 9
Release only / August	Release	none	August 28 - 29
Release + Sylgard / August	Release	Sylgard	August 28 - 29
Vision only / July	Vision	none	July 5 - 9
Vision + Sylgard / July	Vision	Sylgard	July 5 - 9
Vision only / August	Vision	none	August 28 - 29
Vision + Sylgard / August	Vision	Sylgard	August 28 - 29

as butoxyethyl ester (61.6% by volume). The remaining 38.4% is comprised of inert ingredients such as kerosene.

Sylgard® 309 is a water soluble, non-ionic silicone polyether produced by Dow Corning Canada Inc. It is designed to enhance the efficacy of water soluble, post-emergent herbicides. It does this by lowering the surface tension of the herbicide solution, thereby spreading the solution across the leaf surface by reducing the tendency of spray droplets to bead. This results in an increase in the amount and speed of uptake of the herbicide.

Application: Both Vision® and Release® were applied at rates of 6.0 L/ha, the maximum dosages then permitted on each of their labels. This is equivalent to 2.1 kg/ha acid equivalent of glyphosate (as isopropylamine salt), and 2.9 kg/ha acid equivalent of triclopyr (as butoxyethyl ester), respectively. In both cases, the herbicides were mixed with 400 L of water per hectare for a combined application rate of 406 L/ha of herbicide plus water. Sylgard® was used at a rate of 3.75 mL per litre of water, the maximum application rate permitted. The Vision® label has been amended since the time of trial establishment, and application rates of up to 12.0 L/ha are now allowed under certain conditions.

Herbicide solutions were prepared in the field for one plot at a time. Clear, running, sediment-free water from nearby streams was used throughout. All applications were made with a Solo® backpack sprayer equipped with a manual, lever-action pump. The spray mixture was delivered using an even, flat-fan nozzle at the end of a 1.5 m wand, held in front of the applicator at 1.0 m above ground level. At each trial location, the four replicate plots of each treatment were treated consecutively to minimize rinsing of the backpack sprayer and associated risks of contamination.

The treatments were applied at Camp Six on July 5 and August 28, and at Twin Ponds on July 7 and August 29, respectively, in the summer of 1995. Applications were generally made under dry, low-wind conditions. However, evening showers occurred two to three hours after treatment of the Camp Six site on the afternoon of August 29.

***Kalmia* Assessments:** *Kalmia* cover and density were visually assessed on each plot at both locations in early July 1995, prior to the application of the first series of herbicide treatments. Both parameters were rated on a scale of 0 to 10, with 0 representing no cover or density, 1 representing low cover or low density, and 10 representing high cover or high density. The 10 X 10 m plots were divided into four 5 X 5 m sub-plots, and then all sub-plots were rated by two assessors who worked independently. Ratings were compared in the field and a single value per parameter was agreed upon and then assigned to each sub-plot. The assessment was then repeated without reference to the first assessment, and the sub-plot values of the two assessments were averaged. The four sub-plot values were then averaged to give block means, and these were averaged to give a mean treatment value for each site (n = 4). These mean treatment values

were then multiplied by 10 and expressed as percent.

Both herbicide efficacy trials were re-evaluated in the fall of 1998, three years after treatment. *Kalmia* cover and density were assessed in much the same way as prior to establishment in 1995. This time, however, entire plots rather than sub-plots were assessed. As in 1995, two assessors rated each plot, agreed upon a rating for each parameter, and then repeated the assessment, averaged the two values, and converted these to percent.

The main objective of the herbicide efficacy trial was to find a chemical control option for *Kalmia*. Consequently, although a variety of plant species other than Kalmia occurred within the trials, the impact of the herbicide treatments on them was not evaluated. However, the impact of treatments on planted and natural black spruce seedlings was noted so that the utility of the treatments for conifer release could be assessed.

RESULTS

Botwood *Kalmia* Reforestation Field Trial

The height growth of black spruce over eight years following four different treatments at Botwood is shown in Figure 1. Scarification increased total 8-year height from 40 to 60 cm, but controlling *Kalmia* cover using herbicides increased total height to almost 80 cm. Combining both silvicultural treatments increased height growth further to almost 100 cm. It is notable that the height-over-time curves of the treatments were still diverging at eight years.

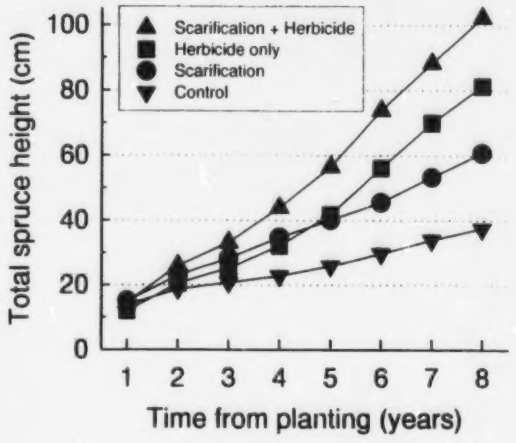

Figure 1. The average height growth of black spruce over eight growing seasons in four treatments at the Botwood *Kalmia* management trial.

Herbicide Efficacy Field Trials

Pre-treatment *Kalmia* cover ranged from 51 to 64% at Twin Ponds, and from 68 to 81% at Camp Six (Table 2). *Kalmia* cover values for control plots were in the mid-range of those found on both sites, and cover on plots to be treated never varied more than 12% from that on control plots (Figure 2).

Third year (1998) assessment results for *Kalmia* cover and density, and percent change from pre-treatment *Kalmia* cover and density, are summarized in Table 2 and Figure 3. While *Kalmia* cover increased in control plots on both sites over the three year period, it decreased on all of the treatment plots except for the Release® only treatment applied in early July at Camp Six. In general, Vision® was slightly more

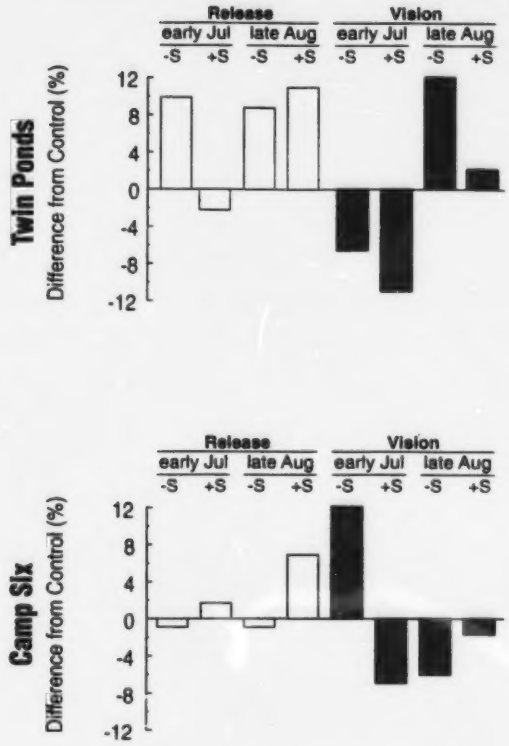

Figure 2. Difference in *Kalmia* cover in plots immediately prior to application of treatments in July 1995, expressed as percent of cover in untreated control plots.

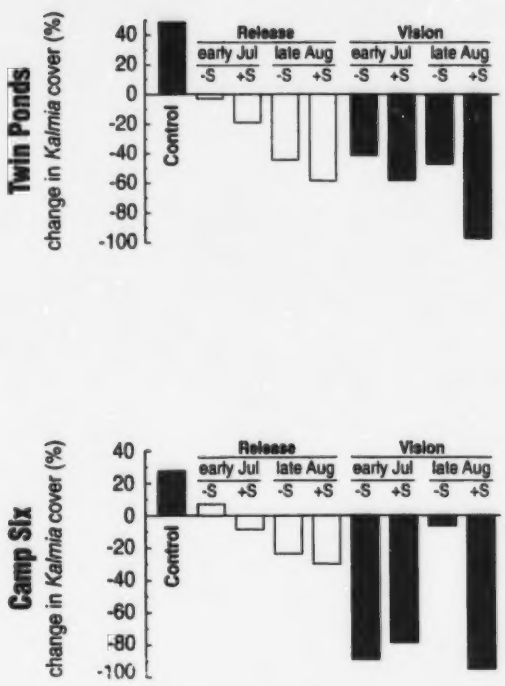

Figure 3. Change in *Kalmia* cover three years after treatment, expressed as percent of cover in plots prior to application of treatments.

effective than Release® at Twin Ponds, but much more effective than Release® at Camp Six (except for the late August application without Sylgard® which was likely washed off *Kalmia* by rain showers several hours after application).

Release® was more effective with than without Sylgard® on both sites at both application times. As well, the Release® treatments were always more effective in late August than in early July. Vision® efficacy in early July was greater with than without Sylgard® at Twin Ponds whereas at Camp Six the Vision® only treatment was more effective. In late August, Sylgard® greatly increased Vision® efficacy at Twin Ponds. At Camp Six, the addition of Sylgard® ensured Vision® efficacy following rain showers. Season of application of Vision® was very important at Twin Ponds, but did not appear to be important at Camp Six.

Overall, the most effective treatment on both sites was Vision® + Sylgard® applied in late August, which reduced *Kalmia* cover by more than 95% compared to pre-treatment levels. Similarly, *Kalmia* density was greatly reduced. The dramatic effect of Vision® + Sylgard® applied in late August on *Kalmia* is further

Table 2. Summary of pre-treatment (1995) and third year (1998) assessments of Kalmia at the Twin Ponds and Camp Six herbicide efficacy trials.

(a) Twin Ponds

Treatment	Cover		% change relative to 1995	Density		% change relative to 1995
	1995	1998		1995	1998	
Control	56.9	84.4	48.4	53.1	96.9	82.4
Release only / July	62.5	60.6	-3.0	56.9	78.1	37.4
Release + Sylgard / July	55.6	45	-19.1	54.4	68.8	26.4
Release only / August	61.9	34.4	-44.4	54.4	46.9	-13.8
Release + Sylgard / August	63.1	26.3	-58.4	55.6	50	-10.1
Vision only / July	53.1	31.3	-41.2	56.3	68.8	22.2
Vision + Sylgard / July	50.6	21.3	-58.0	56.9	53.1	-6.6
Vision only / August	63.8	33.8	-47.1	52.5	59.4	13.1
Vision + Sylgard / August	58.1	1.6	-97.3	53.8	6.3	-88.4

(b) Camp Six

Treatment	Cover		% change relative to 1995	Density		% change relative to 1995
	1995	1998		1995	1998	
Control	72.5	92.5	27.6	63.8	100	56.9
Release only / July	71.9	76.9	7.0	53.8	93.8	74.4
Release + Sylgard / July	73.8	67.5	-8.5	61.9	90.6	46.5
Release only / August	71.9	55	-23.5	62.5	75	20
Release + Sylgard / August	77.5	54.4	-29.8	60	65.6	9.4
Vision only / July	81.3	8.9	-89.1	63.8	31.3	-51
Vision + Sylgard / July	67.5	14.4	-78.7	62.5	40.6	-35
Vision only / August	68.1	63.8	-6.4	60	84.4	40.6
Vision + Sylgard / August	71.3	3.4	-95.2	65.6	15.6	-76.2

shown in Figure 4, where a Vision® + Sylgard®/August treatment plot at Camp Six immediately prior to treatment in 1995 (Figure 4a) is compared with the same plot one year (Figure 4b) and three years (Figure 4c) later, in the fall of 1998. In the latter figure, the treatment is contrasted with an adjacent untreated control plot.

DISCUSSION

The negative impact of *Kalmia* on stand development has been recognized in Newfoundland for decades. It has proven to be

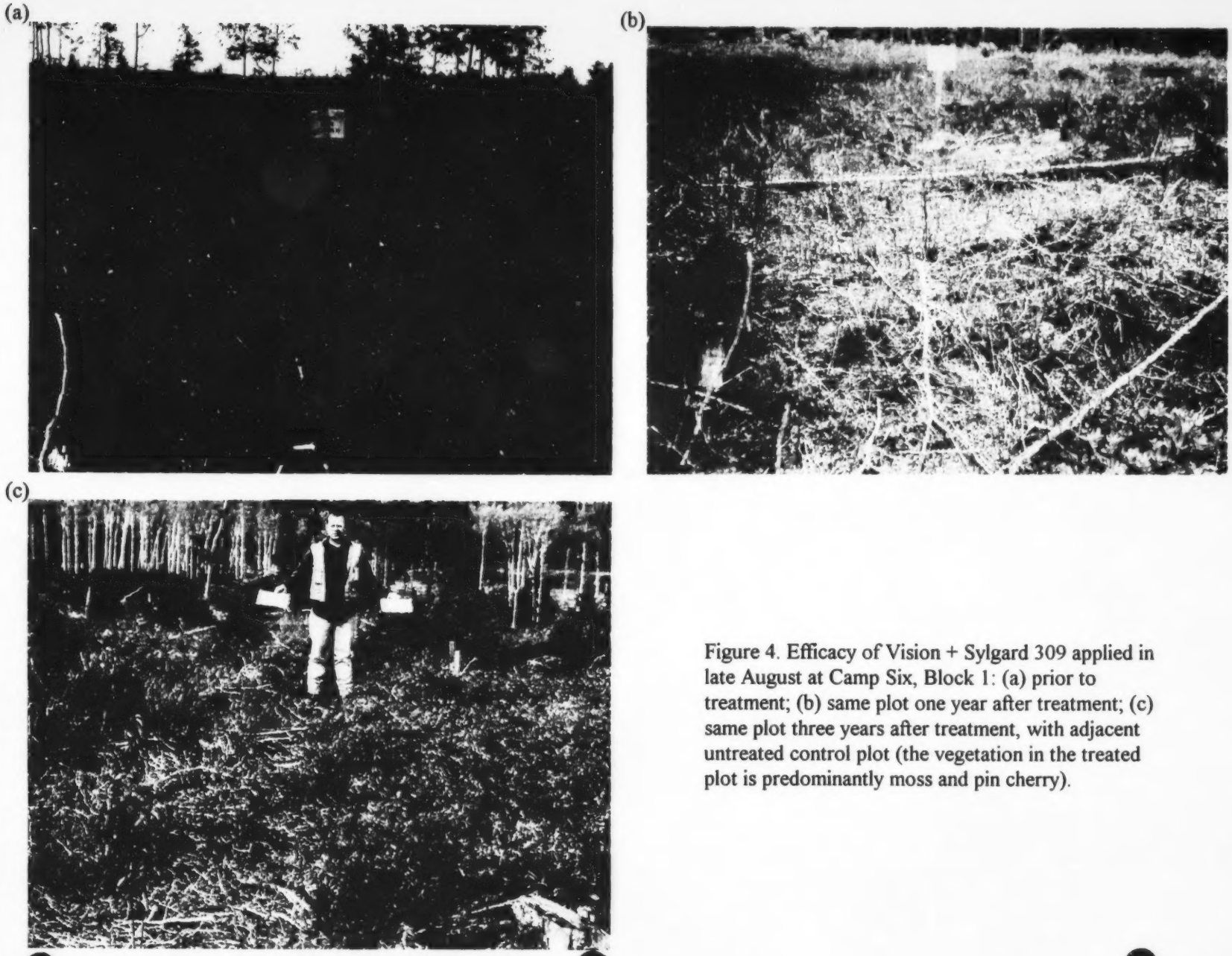

Figure 4. Efficacy of Vision + Sylgard 309 applied in late August at Camp Six, Block 1: (a) prior to treatment; (b) same plot one year after treatment; (c) same plot three years after treatment, with adjacent untreated control plot (the vegetation in the treated plot is predominantly moss and pin cherry).

a highly resilient competitor but the results from Botwood clearly show that even partially controlling *Kalmia* with herbicides can release seedlings from growth check (Figure 1). Scarification alone also improved the long-term growth of spruce but not as much. Seedlings were planted on the hinge position and the bare mineral surface of the trenches presumably provided a *Kalmia*-free environment for spruce root development, at least on one side of the seedlings. Scarification may also provide other benefits to seedlings that cannot be achieved through herbicide application, such as increased soil temperature and mixing of mineral soil and humus. Furthermore, the humus on the Botwood site was quite thin, perhaps because of a wildfire before harvesting, and scarification on sites with thicker humus may confer greater advantages to planted seedlings than those observed. That being said, the herbicide only and scarification only height-over-time curves at Botwood continue to diverge in favour of the herbicide treatment plots. Both mechanical and chemical site preparation together gave the greatest growth increases of all and application of both treatments should further reduce the time to canopy closure, at which point natural shading should eliminate much of the remaining *Kalmia*.

While the results from Botwood conclusively show that spruce will respond well to even a partial reduction in *Kalmia* cover, the two efficacy trials demonstrate that it is possible to achieve excellent control of *Kalmia* with operationally viable treatments. In the first year post-treatment assessment in 1996 it was found that all four Release® treatments had significantly damaged or killed the aerial portions of the *Kalmia*. However, the root systems were apparently unaffected since numerous new *Kalmia* plants originated from rhizomes. No rhizome sprouting was observed in the Vision®-treated plots at the end of the first year. By the time of the third year assessment in 1998, all surviving *Kalmia* (or *Kalmia* regeneration) in treated plots appeared to have returned to its pre-treatment healthy condition, and was similar to that in untreated control plots. No further decrease in Kalmia cover is expected.

Overall, Vision® was more effective than Release®, presumably because of differences in how the two active ingredients affect vegetation. The late August treatments were generally more effective than the early July treatments, probably because *Kalmia* reduces transport of photosynthates to new leaves at this time and increases transport to the rhizomes in preparation for the coming winter. Herbicides are, therefore, moved more efficiently from leaves to rhizomes towards the end of the growing season. Sylgard® generally increased the efficacy of both herbicides by lowering the surface tension of the herbicide solution and spreading it over the waxy *Kalmia* leaves, thereby increasing the amount and speed of uptake of herbicides.

There were evening showers shortly after the herbicide application at Camp Six on August 29. This event inadvertently allowed for a comparison of rainfastness of the two herbicides, with and without the addition of

Sylgard®. As expected from label information, Release® alone was much more rainfast than Vision® alone. The late August Vision® only treatment had little permanent impact at Camp Six, but the addition of Sylgard® to Vision® dramatically enhanced its rainfastness. The efficacy of the Vision® + Sylgard® treatment was therefore excellent despite the occurrence of showers within hours of application. Apparently, the Vision® with Sylgard® was absorbed almost immediately whereas the Vision® without Sylgard® was washed off before it could be fully taken up by the vegetation. The rain showers did not appear to affect the efficacy of the Release® without Sylgard® treatment at Camp Six on this date but, in any case, the effects of all Release® treatments on this site were marginal when compared to the Vision® treatments.

Overall, the most effective treatment at both sites was Vision® + Sylgard® applied in late August. Given the lack of success in controlling *Kalmia* in past trials, the reduction of *Kalmia* cover is dramatic. Although there were fears that the "top kill" observed in the first year would not persist and that plants would resprout from rhizomes, the lack of regeneration and continued low *Kalmia* cover at the end of the third year suggests that this treatment was very effective in killing the *Kalmia* on the two sites. Both time of application and use of Sylgard® were much more important at Twin Ponds than at Camp Six, where neither of these were important factors in determining efficacy. However, until more is known about site-specific effects, it would be prudent to begin operational sprays by applying Vision® + Sylgard® in late August. As the *Kalmia* cover in the treated plots at the Botwood site was far greater than the cover in the successfully treated plots in the efficacy trials, it is possible that greater conifer growth rates than those achieved at Botwood may be observed operationally.

The increase in efficacy and rainfastness of Vision® caused by the addition of Sylgard® was beneficial in controlling *Kalmia* but it also increased damage to black spruce. As expected, the Vision® only treatment in early July (mid-growing season) caused significant damage to spruce whereas the same treatment in late August (end of growing season) caused almost no damage. However, Vision® efficacy increased with the addition of Sylgard® and the late August application of Vision® + Sylgard® caused more damage to both natural and planted black spruce than any other treatment. The types of damage incurred ranged from outright kill, to top kill, to reduced leader growth (Figure 5). By three years post-treatment (1998), the surviving spruce had recovered and little evidence remained of the earlier damage (Figure 6). These sub-lethal to lethal impacts on black spruce (and presumably other conifers) demonstrate that Vision® + Sylgard® should not be used for conifer release unless the manager is willing to accept a degree of damage to existing conifer regeneration.

Based on the third year (1998) assessment of the two efficacy trials, regulatory approval was sought to allow operational application of the Vision® + Sylgard® mixture for controlling *Kalmia* in the field. This was necessary because

Figure 5. Juvenile, natural black spruce killed by the Vision + Sylgard 309 / late August treatment, three years post-application. The live *Kalmia* in the right foreground appears to have been protected by the overtopping spruce at the time of treatment.

Figure 6. Juvenile, natural black spruce recovering from top damage caused by the Vision+ Sylgard 309 / late August treatment, three years after treatment. This suggests that trees that survived the treatment recovered very well within three years.

neither the Vision® nor the Sylgard® labels specifically permitted mixing for this type of use. Consequently, a User Requested Minor Use Label Expansion (URMULE) submission was made to the Pesticide Management Review Agency in Ottawa in the winter of 1999. The URMULE was granted and the Vision® label has now been amended so that Vision® + Sylgard® 309 can be used across Canada against *Kalmia* and other ericaceous species. Approval, however, is limited to site preparation and the label does not permit use for conifer release on existing plantations.

CONCLUSIONS AND RECOMMENDATIONS

This study has shown that spruce will respond to *Kalmia* control and that this control can best be achieved using Vision® + Sylgard® 309 in late August. Furthermore, use of Sylgard® increases rainfastness, thereby also reducing the risk of reduced efficacy because of unexpected rain after application. Based on the results from the Botwood trial and the two efficacy trials, the following conclusions can be drawn:

1. Scarifying *Kalmia*-dominated sites will

increase black spruce growth;

2. Controlling *Kalmia* with herbicides will increase black spruce growth more than scarification on some sites;

3. Scarification in combination with *Kalmia* control using herbicides will increase black spruce growth more than either treatment singly (apply herbicide before scarifying, to maximize foliar uptake);

4. Vision® (6 L/ha) + Sylgard® 309 (3.75 mL/L herbicide solution) applied in late August will give almost complete control of *Kalmia* for at least three years, at which time non-resprouted *Kalmia* plants are likely dead;

5. Vision® (6 L/ha) + Sylgard® 309 (3.75 mL/L herbicide solution) applied in late August can kill black spruce regeneration;

6. A recent URMULE allows for the operational use of Vision® (up to 6 L/ha) + Sylgard® 309 (up to 3.75 mL/L herbicide solution) for chemical site preparation against ericaceous shrubs across Canada.

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REFERENCES

Richardson, J. 1979. A comparison of methods of reforesting sites invaded by *Kalmia angustifolia*, using black spruce. For. Can., Inf. Rep. N-X-174. 26 pp.

Titus, B.D. Research Scientist, Canadian Forest Service. Correspondence to I. Downton, Jan. 12, 1995, regarding 5th year remeasurement of Botwood *Kalmia* management trial.

Titus, B.D. and W.J. Meades. 1988. Proposal for the establishment of an integrated and collaborative field trial and demonstration of methods of *Kalmia* control and subsequent softwood response. Can. For. Serv., NF For. Res. Cent., File Rep. 108. 29 pp.

Titus, B.D. and B. English. 1997. Growth response of conifers following control of *Kalmia angustifolia* L. Pp. 141-147 In P. Comeau and G. Harper, compilers. Expert Committee on Weeds: Proceedings of the 1996 National Meeting. Victoria, BC, 9-12 Dec., 1996.

Titus, B.D., S.S. Sidhu and A.U. Mallik. 1995. A summary of some studies on *Kalmia angustifolia* L.: a problem species in Newfoundland Forestry. Can. For. Serv., Inf. Rep. N-X-296. 68 pp.